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Miniature Remote Control System

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Miniature Remote Control System

INTRODUCTION

The title of this invention is *Miniature Remote Control System*. The residence address for the Applicants, all U.S. citizens, are as follows:

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CROSS-REFERENCE TO RELATED PATENT APPLICATIONS & CLAIMS FOR PRIORITY

The Applicants hereby claim the benefit of priority for any and all subject matter commonly disclosed in the Present Application and any preceding Application:

Pending and allowed U.S. Patent Application Serial No. 09/419,058 filed on 24 September 1999 (CIPD);

U.S. Patent Application Serial No. 08/796,853 (CIPB & CPAC), filed on 6 February 1997, which is now abandoned;

U.S. Patent Application Serial No. 08/459,688, filed on 2 June 1995 (CIPA), which is now abandoned; and

U.S. Patent Application Serial No. 08/060,455, filed on 10 May 1993, which is now abandoned.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable.

FIELD OF THE INVENTION

The present invention relates to radio frequency transmitters. More particularly, this invention provides a miniature transmitter that is small enough to fit within a cigarette lighter socket in an auto dashboard. This invention also provides a receiver which, when activated by the transmitter, is able to operate electrical appliances that are connected to the receiver.

BACKGROUND OF THE INVENTION

Remotely operated garage door openers are a widely used consumer accessory, and are commonly located and activated from a user's vehicle. These devices provide convenience, security and accessibility for many people who desire or require such a system. Remote operation of garage doors, security gates, lighting and alarms has become a necessity for many people.

Existing remote controllers for use in vehicles have had numerous problems associated with their functionality, reliability, security and their location within the vehicle. Common hand-held remote controllers are often bulky and difficult to use. Hand-held units are usually battery operated and commonly malfunction when the

stored battery charge is low. Since vehicles are operated in many weather conditions, the available power from battery operated controllers is diminished in cold temperatures.

Hand-held units are also easily misplaced, either within the vehicle or by inadvertent removal from the vehicle. Looking for a misplaced remote controller can pose a safety problem in a moving vehicle. Hand-held remote controllers are also prone to damage, as they are commonly used at the same time the user is busy operating a motor vehicle. Previous attempts to provide a convenient means for control of remote systems from the auto dashboard have met with limited results.

In U.S. Patent No. 4,286,262, Wahl discloses a system for opening garage doors in which a radio receiver in the garage, upon receipt of a signal, operates to open the garage door and in which a casing containing a radio transmitter is adapted for insertion into the socket of a cigarette lighter in the driver's compartment of a motor car. Wahl also discloses a radio transmitting device in which a casing containing a radio transmitter is insertable into a socket of any type at any location together with means for energizing the transmitter to emit a signal when the casing has been inserted in the socket, for whatever purpose the signal may be utilized.

In U.S. Patent No. 3,967,133, Bokern teaches the construction and use of a relatively simple compact and portable device which makes power available at different desired voltages even at remote locations. Bokern also states that his device

may include means which obviate the possibility of a polarity reversal or misconnection.

In U.S. Patent No. 5,007,863, Xuan discloses a module-type multi-function power outlet adapter for use of add-on electrical accessories in an automotive vehicle having a cigarette lighter socket. This device embodies a plurality of separate detachable modules which may be attached to a basic module insertable into the lighter socket and constructed to receive the additional modules, so to provide multiple electrical outputs. A simple positioning pin structure ensures correct power leads connection and secures the combination between modules. The resulting solid structure allows easy reception for plug-in accessory equipment.

In U.S. Patent No. 5,073,721, Terrill et al. disclose a noise immune electronic switch which is connectible between a cigarette lighter socket of a vehicle and a plug-in accessory device.

In U.S. Patent No. 4,529,980, Liotine et al. Transmitter and receivers for controlling remote elements which use a synchronous serial transmission format and which allows changes in coding to be automatically made between the receiver and transmitter and wherein the code is stored im memories of the transmitter and receiver and wherein the receiver can generate and transmit a new code with a light emitting diode so as to change the code in the transmitter. The transmitter and the receiver use micro-computers which are suitably programmed and include non-volatile memories.

In U.S. Patent No. 4,409,592, Hunt discloses a packet communication system employing a carrier sense multiple access protocol with detection, with an improved means of collision detection and with an improved means for managing access to a communication medium or channel.

In U.S. Patent No. 4,988,992, Heitschel et al. disclose a system for establishing a code and controlling operation of equipment. The system includes a transceiver including a receiver for the signal generated by the first transmitter and memory for storing the code carried by that signal. The transceiver includes a second transmitter for transmitting a radio frequency signal carrying the code.

In U.S. Patent No. 5,148,159, Clark et al. disclose a remote control system including one or more portable units and base unit which employs identification codes for security.

In U.S. Patent No. 4,665,395, Van Ness discloses an automatic vehicular access control system for use by various government, business and private operations having a need to control the entrance of vehicles to their grounds or facilities.

In U.S. Patent No. 4,912,463, Li discloses a remote control apparatus which has a transmitter which is capable of being switched between a normal position and a changing position, and a receiver which is capable of being switched between a normal mode and a changing mode.

In U.S. Patent 4,827,520, Zeinstra discloses a voice actuated control system for controlling vehicle accessories.

In U.S. Patent No. 4,771,399, Snowden et al. disclose a memory programming system which provides a method and apparatus for programming and reading an electronic device memory through its power source connections.

In U.S. Patent No. 3,906,348, Wilmott discloses a serially transmitted code which can be detected by a receiver.

In U.S. Patent No. 4,241,870, Marcus discloses a housing mounted between the visors in the headliner of a vehicle for receiving and supplying operating power to a remote transmitter used for opening garage doors.

Previous inventions, such as the device described in U.S. Patent No. 4,241,870 by Marcus, have located the portable transmitter unit in a overhead location within the motor vehicle, picking up electrical power through a socket located in an overhead console. These units rely on carrier signal technologies, and require line-of-sight operation through the vehicle windshield. Marcus claims that by mounting the transmitter high in a console, the radio waves will exit through the windshield, thus providing the required line of sight operation. Marcus located the controller overhead, in the visor area of an automobile, which has met with minimal acceptance by both automobile manufacturers and consumers. These controller modules are

unique to different vehicle models. They impair vision out the front of the vehicle, and cannot be applied to many models, such as convertibles. Special wiring extensions to supply power to these overhead consoles are also required, adding to the manufacturing cost of vehicles supplied with such systems.

Hand-held transmitter systems that require a specialized storage area within a vehicle tend to be inappropriate for the interior designs of most vehicle manufacturers. Most hand-held transmitters use carrier signals that require "line of site" operation through the vehicle windshield area. These transmitters use carrier signals with a small number of unique codes. This can pose a security risk when security gates and garage doors are opened inadvertently or deliberately by other transmitters that use the same carrier signal code.

U.S. Patent No. 3,906,348, by Wilmott, provided further encoding and decoding for transmitter and receivers for digital radio control, but the hardware design is inappropriately expensive for integration into a consumer product.

Previous remote controllers have been used in motor vehicles to operate garage doors and similar devices. These existing remote controllers are typically large, awkward, and have proven to be difficult to integrate with modern automobile design. While large automobiles, such as Cadillacs™ and Lincolns™, may have enough room over the rear-view mirror, most cars do not have enough space for such large devices. Since most controller designs require line of sight operation, they are susceptible to

interference. A significant number of existing remote controller designs fail to offer reasonable security for the user, due to a large number of users and a small number of unique codes. The development of a miniaturized, inexpensive remote controller that can be installed directly in an existing cigarette lighter enclosure, that can provide interference-free operation from a reasonable distance, while providing a large number of unique codes, would constitute a major technological advance. The enhanced performance that could be achieved using such an innovative device would constitute a major technical advance and satisfy a long felt need within the consumer marketplace.

SUMMARY OF THE INVENTION

The *Miniature Remote Control System* disclosed and claimed below overcomes the problems encountered by previous mobile remote control systems. The *Miniature Remote Control System* integrates a radio circuit in a small device that can fit inside a cigarette lighter enclosure in an automobile, truck, van, forklift or other vehicle. When activated, it can be used to open garage doors and security gates, activate or deactivate burglar alarms, turn on lights inside or outside the home, or activate other devices from a remote location.

The remote control transmits a coded serial pulse train to a receiver up to 200 feet away. The transmitter board fits inside a cigarette lighter housing and simply plugs into the existing lighter receptacle in a car. A miniature switch located on top of this housing is manually activated to transmit a unique code (one of 19,683) on a 380 MHz carrier frequency. The receiver processes the carrier signal, and extracts the serial code. The code is then compared to the preset code, and, if a match is found, a relay is triggered.

The innovative *Miniature Remote Control System* incorporates the latest remote control technology in a package that is small, safe, reliable, cost-effective, and appropriate for wide acceptance throughout the automotive industry. Installation of the present invention simply entails replacing a standard cigarette lighter with the a remote emitter, which is designed to fit within and operate from a standard lighter

receptacle, which is supplied and conveniently located within all modern vehicles. The majority of people who drive vehicles do not smoke, allowing wide market acceptance of the use of the remote emitter located within the standard lighter receptacle. This invention will become the standard-bearer for remote control technology and constitutes a major step forward in the field of automotive accessory design.

An appreciation of other aims and objectives of the present invention and a more complete and comprehensive understanding of this invention may be achieved by studying the following description of a preferred embodiment and by referring to the accompanying drawings.

A BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an illustration of the *Miniature Remote Control System*, using a cutaway view of a garage area of a building. This illustration shows how the present invention would be used to provide remote operation of a standard garage door opener mechanism.

Figure 2 is a perspective assembly view of the remote emitter and a matching lighter receptacle into which the remote emitter would be installed.

Figure 3 is an depiction showing the remote emitter installed within the interior of a vehicle. As the vehicle approaches a garage, the remote emitter is activated to send a carrier signal to open a garage door.

Figure 4 offers a detailed view of a carrier signal being emitted from a vehicle equipped with the remote emitter, as the vehicle approaches the location of the remote receiver.

Figure 5 is an alternative embodiment of the present invention, in which the remote receiver is an integral component of a garage door opener.

Figure 6 is a plan view that illustrates some of the remote control applications for which the *Miniature Remote Control System* can be used.

Figure 7 is a schematic of the remote emitter.

Figure 8 is a schematic diagram of the remote receiver.

Figure 9 is a schematic of the receiver power supply.

Figure 10 is a depiction of the receiver board layout for the present invention.

Figure 11 shows an embodiment of the second receiver board layout.

Figure 12 shows a top view of a board design for a production transmitter.

Figure 13 shows a side view of the production transmitter board.

Figure 14 illustrates details the component side of the bare production transmitter board.

Figure 15 provides a detailed view of the circuit side of the bare production design transmitter board.

Figure 16 is a composite view of the production transmitter board.

Figure 17 is a top view of the surface mount transmitter board embodiment.

Figure 18 is a detailed plan view of the surface mount remote emitter assembly.

Figure 19 is a detailed side view of the surface mount remote emitter assembly.

Figure 20 provides a plan view of an alternate transmitter embodiment.

Figure 21 is a side view of the alternate transmitter embodiment.

Figure 22 shows the remote emitter designed to fit in the cigarette lighter receptacle of a Lincoln™ automobile.

Figure 23 shows the remote emitter designed to be used in the cigarette lighter receptacle of a Mercedes Benz™.

Figure 24 is an expanded view of an alternate embodiment of an extended remote emitter.

Figure 25 shows an installed view of the extended remote emitter.

Figure 26 reveals a block diagram of another alternate embodiment of the present invention, the Miniature Transceiver Control System.

Figure 27 is a perspective illustration of the remote transceiver, as it would be installed in the console of a vehicle.

Figure 28 is a block diagram of the power circuitry for the remote transceiver.

Figure 29 is a schematic diagram of an alternate embodiment of the transmitter circuitry.

Figure 30 is a schematic diagram of an alternate embodiment of the remote receiver.

Figure 31 is a schematic of an alternate embodiment of the receiver power supply.

Figure 32 is a depiction of an alternate embodiment of the receiver board layout.

Figure 33 is an alternate embodiment of the second receiver board layout.

Figure 34 is an alternate embodiment of the surface mount transmitter board.

Figure 35 is an alternate embodiment of a remote emitter designed to fit within the cigarette lighter receptacle of a Lincoln™ automobile.

Figure 36 is an illustration of a standard cigarette lighter designed to fit within the cigarette lighter receptacle of a Mercedes Benz™.

Figure 37 is an alternate embodiment of a remote emitter designed to fit within the cigarette lighter receptacle of a Mercedes Benz™.

Figure 38 is an expanded sectional assembly view of the remote emitter shown in Figure 37.

Figure 39 is an assembly illustration of the remote emitter shown in Figure 37.

Figure 40 reveals an enlarged sectional illustration of the remote emitter shown in Figure 37.

Figure 41A provides a perspective view of the circuit used in an alternate embodiment of the remote emitter. Figure 41B is a detailed perspective view of the switch and antenna circuit shown in Figure 41A.

Figure 42 is a cross-sectional view of a remote emitter which uses the circuit board shown in Figure 41A.

Figure 43 provides a schematic diagram of an alternate embodiment of a remote emitter designed to operate at 915 MHz.

Figure 44 provides a schematic of the PC remote interface, and is an example of the circuitry used to program the transmitter through the power line.

Figure 45 is a block diagram of one embodiment of the transceiver which uses an LCD Display.

Figure 46 provides a block diagram of an integrated system for use in gated communities.

Figure 47 is a schematic diagram of a 900 MHz RF super regenerative receiver.

Figure 48 is a schematic diagram the circuitry for a 900 MHz transmitter.

Figures 49, 50 and 51 provide software flow charts which indicate the process by which the basic receiver and transmitter operate.

Figures 52 and 53 are side views that reveal the top and bottom of one of the preferred embodiments of the housing.

Figures 54 and 55 are cross-sectional views of the housing shown in Figures 52 and 53.

Figures 56A through 56F present views of the housing mold.

Figures 57A and 57B depict the ground ring.

Figures 58 and 59 are side views that reveal the top and bottom of one of the alternative embodiments of the housing.

Figures 60 and 61 are cross-sectional views of the housing shown in Figures 58 and 59.

Figures 62A through 62F present views of the housing mold.

Figures 63A and 63B depict the ground ring.

Figures 64A, 64B and 64C provide illustrations of a printed circuit board.

Figures 65A, 65B and 65C reveal the details of a transmitter button.

Figures 66A and 66B portray the transmitter cap.

Figures 67A and 67B illustrate the transmitter power ring.

Figures 68 through 74 furnish successive views of manufacturing steps which may be employed to construct the present invention.

DETAILED DESCRIPTION OF PREFERRED & ALTERNATIVE EMBODIMENTS

System Overview

Figure 1 is an illustration of the *Miniature Remote Control System* 10, which shows a cutaway view of a garage area G. The *Miniature Remote Control System* 10 provides a miniature, radio frequency remote emitter 12 that is designed be installed within a vehicle V. The remote emitter 12 is used to operate an external device ED, such as a garage door opener GDO, that is connected to a remote receiver 14. When activated, the remote emitter 12 transmits a 380 MHz coded serial pulse train 16. At this frequency, the coded serial pulse train 16 can easily penetrate obstructions located between the remote emitter 12 and the remote receiver 14, such as the vehicle V, the vehicle windshield W, the garage wall GW, and the garage door GD. In the claims, the term "carrier signal" encompasses any coded serial pulse trains 16 described in the specification.

The remote emitter 12 is able to transmit the serial pulse train 16 to the remote receiver 14 from a distance up to 200 feet away. When in range, the remote receiver 14 senses the incoming serial pulse train 16 through the receiver antenna 18. The remote receiver 14 processes the coded signal pulse train 16, and extracts the serial transmitter code 20. The transmitter code 20 is then compared to the preset receiver code 22. If the transmitter code 20 and the receiver code 22 are identical, the remote

receiver 14 provides the logic necessary to provide power to operate an external device ED, such as the garage door opener GDO.

The remote receiver 14 is powered by a 16 volt direct current power converter 24 which is attached to an existing alternating current power source (VAC). In this embodiment, the garage door opener GDO can also be activated by overriding the remote receiver 14 by using a manual button MNL.

Figure 2 shows a perspective view 26 of the remote emitter 12 and portrays how the remote emitter 12 would be installed in a cigarette lighter receptacle 28 which is located in a vehicle V. The lighter receptacle 28 is supplied with a direct voltage source BAT from the vehicle V, with a positive polarity connection 30 and a negative polarity connection 32.

The emitter body 34 of the remote emitter 12 is an exterior housing that encloses the internal components of the remote emitter 12. An emitter retainer 36 is used to correctly locate the remote emitter 12 within the lighter receptacle 28. The emitter retainer 36 also acts as an electrical conducting channel between the remote emitter 12 and the negative polarity connection 32. A switch 37 is located on top of the emitter body 34, which is manually activated by the user to power the remote emitter 12 and send a serial coded pulse train 16.

A view of the installed controller 38 is shown in Figure 3. The remote emitter 12 is installed in a lighter receptacle 28 which is located inside a vehicle V. The lighter receptacle 28 is located in different locations within the vehicles V of various manufacturers, but is usually located on the dashboard D or a console C, as indicated by Figure 3. The location of the lighter receptacle 28 is designed by vehicle manufacturers to be conveniently accessed by the driver or passenger while they are seated in seats S.

Figure 3 also portrays how the remote emitter 12 would be used to transmit a coded signal pulse train 16 towards a garage G and a garage door GD. As a driver located in vehicle V approaches a garage G, the driver can easily reach and activate the remote emitter 12 by simply pushing down the switch 37 on top of the emitter body 34. Upon activation, the remote emitter 12 emits the coded serial pulse train 16, which includes a unique transmitter code 20 (one of 19,683) on a 380 MHz carrier frequency.

Figure 4 shows a detailed illustration 40 of an approaching vehicle V as it arrives at a residential building B and a garage G. The coded serial pulse train 16 is transmitted from a remote emitter 12 located in the vehicle V. In this application, the pulse train 16 is used to activate a remote receiver 14 that can provide the logic necessary to open or close a garage door GD.

Figure 5 is a depiction 42 of an alternative embodiment of the present invention in which the remote receiver 14 is contained within an integrated garage door opener 44.

Figure 6 is a plan view 46 of some of the many useful applications for which the *Miniature Remote Control System* 10 may be used. Upon arriving at or departing from a building B, a user in vehicle V can activate the remote emitter 12 to send a coded serial pulse train 16 to a security gate receiver 48 in order to open or close a security gate SG. Exterior lighting EL can be controlled in a similar manner using an exterior light receiver 50. Sprinklers LC can be activated or shut off using a landscape control receiver 52, thus allowing the vehicle passengers to exit the vehicle V without getting wet. The remote emitter 12 may also be used to arm or to disarm a home alarm and security system SA by using a security system receiver 54. Other devices inside the building B may activated, by using a remote emitter 12 to activate an interior lighting receiver 56 to turn lights IL off or on around the house B, or by activating a climate control receiver 58 to operate heating and air conditioning systems AC.

A schematic diagram of the transmitter circuitry 60 within the remote emitter 12 is revealed in Figure 7. To activate the remote emitter 12, the user simply pushes down the switch 37 on the emitter body 34, which allows the transmitter circuitry 60 to be energized with the 13.7 volt DC power supplied by the positive polarity connection 30 and the negative polarity connection 32 in the vehicle V.

The transmitter circuitry 60 incorporates three primary systems, including the emitter power supply 62, the emitter encoder 64, and the emitter oscillator 66. The emitter power supply 62 provides filtered direct voltage power to the emitter encoder 64 and the emitter oscillator 66. The emitter encoder 64 uses an encoding chip 68, which in this embodiment is an MC 145026, manufactured by Motorola. Nine trinary code input traces 70 are supplied into the encoding chip 68. When the transmitter circuitry 60 is manufactured, the input traces 70 are selectively cut to produce high, low, or open states. In this manner, each remote emitter 12 produced can have one of 19,683 unique transmitter codes 20, derived from 3^9 possible configurations.

A timing network 72 is also provided within the emitter encoder 64. The timing network 72 consists of an RTC timing resistor 74, a CTC timing capacitor 76, and a source resistor 78. The source resistor 78 is used as a buffer for the timing network 72. The clock frequency of the encoder 64 is determined by the selection of values for the RTC timing resistor 74 and the CTC timing capacitor 76. This frequency is determined by the following relationship:

$$\text{Clock Frequency (cycles/sec)} = 1/(2.3 * CTC * RTC).$$

To obtain more unique transmitter codes 20 for the remote emitter 12 than the 19,683 possible combinations offered by the encoding chip 68 alone, values of the RTC timing resistor 74 and the CTC timing capacitor 76 can be changed.

When activated, the emitter oscillator 66 produces the encoded serial pulse train 16. A 1.0 uH 5% emitter inductor 80 acts as a filter in the transmitter circuitry 60 to isolate the 380 MHz signal produced by the emitter oscillator 66 from the clean voltage necessary for operation of the encoding chip 68. A signal resistor 82 is located between the emitter encoder 64 and the emitter oscillator 66. The value chosen for the signal resistor 82 determines the transmission power of the remote emitter 12. In the preferred embodiment, a 33K signal resistor 82 is used to provide interference free operation between the remote emitter 12 and a remote receiver 14 up to 200 feet away. Appropriate values for the signal resistor 82 are also limited by the maximum allowable transmission power dictated by the Federal Communications Commission (FCC).

A coupling transformer 81 is used to isolate the transmitter circuitry 60 from the emitter antenna 83. This creates a better impedance match between the transmitter circuitry 60 and the emitter antenna 83. In one embodiment of the invention, a circuit trace 122 on the bare production transmitter board 118 may be employed as an antenna for the remote emitter 12. In another embodiment of the present invention, the emitter switch 37 is linked to the emitter oscillator 66. When the switch 37 is depressed by the user, the user becomes the emitter's antenna, and provides an unobstructed line of sight for the coded serial pulse train 16 through the vehicle windshield WS.

Figure 8 is a schematic diagram of the receiver circuitry 84 used with the remote receiver 14. The incoming 380 MHz serial pulse train signal 16 arrives at the receiver antenna 18, and is then processed by an rf super-regenerative receiver 86. The super-regenerative receiver 86 operates with an extremely wide bandwidth, which allows the *Miniature Remote Control System* 10 to operate over a very large temperature range. Since the ambient temperature of the remote emitter 12 in a vehicle V or the remote receiver 14 in a building B can commonly be anywhere from 15 degrees F to 130 degrees F, the 380 MHz coded serial pulse train 16 can have a tolerance of as much as +/- 5 MHz.

A high frequency filtering circuit 88 is coupled to the super-regenerative receiver 86. Two 0.001F high frequency filter capacitors 90 are coupled to a filter transistor 92. The high frequency filter capacitors 90 act as a buffer between the super-regenerative receiver 86 and the receiver amplifier 94 and data separator 98 circuits.

A data amplifier 94 is then used to begin to amplify the encoded serial pulse train 16. An operational amplifier 96 is used to amplify the 10 KHz serial pulse train 16 by a factor of 10. The operational amplifier 96 has a low frequency bandwidth of only 1-4 MHz, and acts to further filter any residual high frequency components.

A data separator 98 is coupled to the receiver amplifier 94. The data separator 98 adjusts itself to the output signal of the first operational amplifier 96, to allow for

signal shift due to temperature variations in the remote emitter 12. The data separator 98 uses a second operational amplifier 100 to compare the actual serial pulse train 16 to the averaged dc level of the serial pulse train 16. A slight amount of hysteresis is added through a 1.5 Meg-ohm resistor 101. This provides clean switching and enhanced noise rejection. The output of the data separator 98 is a faithful reproduction of the serial pulse train 16 output from the emitter encoder 64.

The remaining serial pulse train 16 is output from the data separator 98 to a receiver decoder 102, which in this embodiment is an MC 145028, manufactured by Motorola. The receiver decoder 102 is preset when manufactured with a trinary receiver code 22 to match the transmitter code 20 from the encoding chip 68 in the remote emitter 12. The receiver decoder 102 compares the transmitter code 20 to the receiver code 22. If the two codes 20 & 22 are identical for two sequential serial pulse trains 16 received from the remote emitter 12, the receiver decoder 102 supplies the necessary logic to trigger a relay 104 that will activate the 16 volt DC signal 106 necessary to implement the exterior device ED, such as a garage door opener GDO.

Figure 9 is a schematic of the receiver power supply 108 which is used to supply the regulated 12 volt DC power necessary for proper function of the receiver circuitry 84 as well as the 16 volt DC power 106 necessary to power the relay 104.

Figure 10 shows the first receiver circuit board 110 used in the 380 MHz remote receiver circuitry 84, which includes the super-regenerative receiver 86, the

receiver amplifier 94, and the data separator 98. Figure 11 reveals a second receiver circuit board 112 that is used in conjunction with the first receiver circuit board 110 to complete the receiver circuitry 84 within the remote receiver 14. The second receiver circuit board 112 includes the receiver decoder 102 and the receiver power supply 108.

For the remote emitter 12 to fit within in a small area such as a lighter receptacle 28 within a vehicle V, the transmitter circuitry 60 must be able to be packaged within an extremely small volume. Figures 12 through 16 illustrate different views of the components that make up the transmitter circuitry 60 within the remote emitter 12. Figure 12 shows a top view the stacked production transmitter board 114 that achieves all the functionality required of the transmitter circuitry 60 in a micro-miniature design that can fit within the emitter body 34 of the remote emitter 12. Figure 13 reveals a side view 116 of the production transmitter board 114, whose components and layout have been advantageously chosen to minimize the exterior dimensions of the transmitter circuit board 114.

Figure 14 illustrates details the component side of the bare production transmitter board 118, from which components are assembled to make up the completed production transmitter board 114. The bare transmitter board 118 is designed to preserve the compact nature of the completed transmitter board 114, while minimizing trace path lengths, and providing adequate room for assembly, quality control, and heat rejection.

Figure 15 provides a detailed view 120 of the circuit side of the bare transmitter board 118. All board traces 122 on the bare transmitter board 118 are designed to be as short as possible to minimize circuit response time and heat loss, while still providing adequate distance between traces 122 to avoid malfunctions.

Figure 16 provides a composite view 124 of the production transmitter board 114. This view exemplifies how the components that make up the board 114 have been arranged to advantageously provide an extremely small volume while still allowing adequate room for manufacture, heat rejection, and testing.

Figure 17 is a top view of a preferred surface-mounted transmitter embodiment 126. The surface-mount transmitter 126 provides all the functionality required for the remote emitter 12, while advantageously employing surface-mounted component assembly design. As the remote emitter 12 can be used for numerous applications, the cost to manufacture the components must be considered to provide as large an installed customer base as possible. Modern automated manufacturing methods and the availability of high quality "surface-mount" electronic components at a reasonable cost has made the surface-mount transmitter 126 desirable to achieve the lowest possible cost of the present invention for the user.

Figure 18 reveals a detailed plan view 128 of the remote emitter 12. The surface-mount transmitter board 126 is installed inside the emitter body 34. To provide the mechanical connection to locate the remote emitter 12 within the lighter

receptacle 28, and to provide the proper electrical pathway between the remote emitter 12 and the negative polarity connection 32, an emitter retainer 36 is provided. The emitter retainer 36 is attached to the emitter body 34 with a spring 130 and a snap ring 132. The spring 130 and snap ring 132 act to provide the user of the remote emitter 12 with a tactile feel when the button 37 is pushed, similar to the spring loaded "snap" of a calculator keypad button that provides a user with a tactile response.

Figure 19 provides a detailed side view 134 of the embodiment of the remote emitter 12 shown in Figure 18. This view illustrates how the necessary electronic components that make up the surface mount transmitter 126 are placed to fit within the confines of the emitter body 34 with generous tolerances, allowing the use of multiple parts sourcing for non-interrupted, large-volume manufacture of the remote emitter 12.

Figure 20 provides an enlarged cut-away plan view of an alternate transmitter embodiment 136 of the remote emitter 12. From this view it can be seen how the surface-mount transmitter circuit board 126 that provides all the required functionality of the remote emitter 12 can be conveniently packaged within the exterior body 34 that can be installed in a common lighter receptacle 28.

Figure 21 is an enlarged sectional side view 138 of the alternate transmitter embodiment 136 shown in Figure 20. In this view the transmitter conductive pathway 140 is shown. The conductive pathway 140 makes contact with the positive polarity

connection 30 in the vehicle V when the user pushes the button 37 to activate the remote emitter 12. This powers the remote emitter 12 to send a coded serial pulse train 16 to the remote receiver 14 for remote control of an external device ED, such as a garage door opener GDO.

The lighter receptacles 28 and the interior design requirements of vehicles V produced by various manufacturers require that the remote emitter 12 be packaged with slightly different geometries and styling. The production transmitter board 114 is designed to be located within all appropriate emitter bodies 34 which are designed to fit within the standard lighter receptacles 28 of vehicles V produced by substantially all manufacturers. Figure 22 shows a side view of a remote emitter 141 designed to fit in a Lincoln™ automobile. Figure 23 reveals a side view of a remote emitter 142 designed to be used in a Mercedes Benz™.

Figures 24 and 25 are detailed expanded and installed assembly views of an alternate embodiment of the extended remote emitter 144. This configuration allows expanded functionality and versatility that is advantageous for many users. The extended remote emitter 144 allows the user to control multiple devices ED remotely from a vehicle V, by providing the circuitry and controls to send a number of unique coded serial pulse trains 16 to different external devices ED, such as a garage door opener GDO, a security system receiver 54, a lighting control receiver 56, and a security gate receiver 48. The multiple button keypad 146 shown in Figure 24 has single buttons 148 devoted to single transmitting functions. Other embodiments that

require increased security or the use of a small number of buttons 148 to control a large number of external devices ED may use a keyed combination of required button strokes to provide the correct coded serial pulse train 16 to operate external devices ED.

The location of the multiple button keypad 146 for this embodiment is placed to be easily seen and operated by the user within the vehicle V. To enhance the ease with which the extended remote emitter 144 is used, the single buttons 148 can be color keyed, illuminated, or supplied with names or icons to identify the functions for which they are to be used.

Another feature of the extended remote emitter 144 is the extension receptacle 150 that is shown in Figure 24. Many modern vehicles V are equipped with optional accessories ACC such as portable cellular phones CP, which often use the lighter receptacle 28 within a vehicle V to supply DC power. The extension receptacle 150 provided by the extended remote emitter 144 allows the attachment of additional accessories ACC, such as cellular phones CP. As the extended remote emitter 144 is designed to draw a very small amount of power from the vehicle DC power source BAT, the use of both the extended emitter 144 and a cellular phone CP within the lighter receptacle 28 is within the amperage limits of vehicle electrical circuit BAT, which is designed to power a cigarette lighter CL.

Figure 26 reveals a block diagram of another alternate embodiment of the present invention, the Miniature Transceiver Control System 152, which comprises a remote transceiver 154 in a vehicle V, and a secondary transceiver 156 attached to external devices ED. The Miniature Transceiver Control System 152 provides both remote control of external devices ED from a vehicle V, and communication back to the remote transceiver 154 from the secondary transceiver 156.

The Miniature Remote Transceiver System 152 is able to transmit and receive information on a carrier frequency of 902 to 928 MHz. The Federal Communications Communication (FCC) allows a high maximum transmission power for systems operating in the 900 MHz bandwidth. Operation of the Miniature Transceiver Control System 152 in this 900 MHz frequency band allows the system to operate with a range exceeding two miles, while advantageously providing interference free operation from obstacles, such as the vehicle body VB, buildings B, and garage walls GW.

A user in a vehicle V can activate the remote transceiver 154 to send a coded serial pulse train 16 by simply pressing down on buttons 148 located on the transceiver keypad 160. Activation of a desired coded serial pulse train 16 may be accomplished with a stroke of an individual button 148, or may be accomplished with a more elaborate predetermined combination of multiple buttons 148. The transceiver keypad 160 is coupled in series to a transceiver microprocessor 162, a transceiver transmitter 164, and a transceiver antenna 166. When the user supplies the correct transmitter code 20 to the transceiver microprocessor 162, the transceiver

microprocessor 162 activates the transceiver transmitter 164 to send the appropriate coded serial pulse train 16 containing the transmitter code 20. The coded serial pulse train 16 provided by the transceiver transmitter 164 is broadcast from the vehicle V, through the transceiver antenna 166, toward the secondary transceiver 156.

The secondary transceiver 156 is typically located in a building B, and is powered by a standard 120 volt alternating current source VAC. The secondary transceiver 156 has inputs for connection to external devices ED, such as security and alarm systems SA, fire detectors FD, garage door openers GDO, and heating and air conditioning systems AC.

The secondary transceiver 156 is able to receive, amplify, and decode the coded serial pulse train 16 sent by the remote transceiver 154, and is able to activate external devices ED, such as security and alarm systems SA and garage door openers GDO. The secondary transceiver 156 is also able to transmit an information pulse train 158 back to the remote transceiver 154.

The remote transceiver 154 is able to receive the information pulse train 158 from the secondary transceiver 156. The information pulse train 158 may contain information for use by the transceiver microprocessor 162, such as new transmitter codes 20 required to provide remote control for external devices ED. The information pulse train 158 may also contain information to be communicated to the user, such as the status of external devices ED, or confirmation of commands sent to the secondary

transceiver 156 by the remote transceiver 154. Information regarding the status of external devices ED that can be transmitted to the user may be of great value to the user in a vehicle V. Criminal activity that activates a security and alarm system SA which is connected to a secondary transceiver 156 in a building B can be communicated to a user in a vehicle V. A fire within a building B that activates a fire detector FD which is connected to a secondary transceiver 156 can be communicated to a user.

The information pulse train 158 sent by the secondary transceiver 156 enters the remote transceiver 154 through the transceiver antenna 166. The transceiver antenna 166 is coupled in series to the transceiver receiver 168, the transceiver microprocessor 162, and a backlit liquid crystal display 170. The transceiver microprocessor 162 is also coupled to function LEDs 172. When an information pulse train 158 arrives at the transceiver antenna 166, it is processed by the transceiver receiver 168 and sent to the transceiver microprocessor 162. If the information pulse train 158 contains information for use only by the transceiver microprocessor 162, such as a new transmission code 20, the transceiver microprocessor 162 stores the new transmission code 20 in its memory. If the information pulse train 158 contains information to be communicated with the user in the vehicle V, the transceiver microprocessor 162 sends the information to the liquid crystal display 170 or to the function LEDs 172, where the information is provided to the user.

Figure 27 is a perspective illustration 174 of the remote transceiver 154, as it would be installed in the console C of a vehicle V. In this embodiment, the remote transceiver 154 is designed to fit within a standard ash tray AT in a vehicle V. A power pickup 176 is provided on the remote transceiver 154 to supply power to the remote transceiver 154 from the vehicle DC power source BAT. The power pickup 176 is designed to fit within a standard cigarette lighter receptacle 28. The transceiver keypad 160 is conveniently located on the upper surface of the remote transceiver 154. A backlit liquid crystal display 170 and a function LED 172 are also provided on the upper surface of the remote transceiver 154, to provide communication to the user from the secondary transceiver 156 in the house B. An extension receptacle 150 is also provided on the remote transceiver 154 to provide a means for attachment of additional accessories ACC, such as cellular phones CP. To install the remote transceiver 154, the cigarette lighter CL and ash tray AT can simply be removed and replaced with the remote transceiver 154.

Figure 28 is a block diagram of the power circuitry 178 for the remote transceiver 154. Power is supplied to the remote transceiver 154 from the vehicle DC power source BAT through the power pickup 176. A transceiver power supply 180 is located within the remote transceiver 154, and is coupled to the power pickup 176. The transceiver power supply 180 conditions the DC power source BAT to provide appropriate power outputs 182 for components in the remote transceiver 156 and for secondary accessories ACC that are coupled to the extension receptacle 150.

Alternate Antenna Configurations

The operating frequency and radiated power of the present invention is regulated by the FCC. This device must operate within the constraints of those regulations. Under Section 15.231, periodic operation in the band 40.66-40.70 MHz and above 70 MHz of remote control devices such as garage door openers are allowed. Since the allowable radiated field strength is low (<12,500 μV/ meter average value measured at 3 meters for frequencies above 470 MHz), the method of coupling the RF energy into the antenna can be primarily driven by economics as opposed to power efficiency. Most importantly, the RF energy must exit the car, usually through a multipath composing of several reflections, and enter the house or a garage where a receiver intercepts the signal and operates the garage door or other device.

Figure 41A provides a perspective view of the circuit used in an alternate embodiment of the remote emitter. Figure 41B is a detailed perspective view of the switch and antenna circuit shown in Figure 41A. Figures 42 is a cross-sectional view of a remote emitter which uses the circuit board shown in Figure 41A. In this embodiment, the antenna consists of a PWB trace and the switch "button" that activates the transmitter. In a preferred embodiment, the switch is encapsulated within the button included in the remote emitter, and essentially acts as an antenna as well as a DC power path from the battery to the transmitter. This approach has several advantages. First, this approach is economically manufactured, since the complexity of the PWB is reduced. Secondly, the button is the highest point above

ground and has a large surface area. This allows for greatly enhanced radiation efficiency out of the automobile. Normal wire antennas such as monopole or dipole antennas are isotropic. This means the antenna radiates equally well over 4π steradians (a sphere). The switch approaches a patch antenna due to the large amount of surface area. This gives the radiated pattern directivity in the vertical direction as shown in Figure 41B.

The frequency is a critical parameter in determining how effective the above features lend to better performance in small volumes such as a cigarette lighter. Higher frequencies allow for smaller circuit components. Antenna size is proportionally related to the wavelength as well as to the propagating wave's ability to penetrate buildings. Smaller wavelengths have less path loss in buildings. Larger wavelengths tend to be obstructed by plumbing and electrical wiring. For the purpose of this invention there is no restriction on the choice of frequency except as outlined in FCC 15.231. However, at this time, the frequency chosen is approximately 900 MHz and is based on economics. The future frequency could end up close to 2000 MHz due to the smaller size of available components.

Modulation & Message Coding

The basic system operates at 900 MHz when the operator presses the button labeled "Close Switch." At the time of switch closure, the transmitter begins sending a coded message to the receiver. Once activated by the switch, the transmitter automatically ceases transmission within five seconds after the switch is released.

There are two key features of the coded message. First, a unique code is repeatedly transmitted. The receiver is designed to look for codes that have been identified as valid for executing the desired remote function such as opening the garage door. The receiver must receive the same correct code three times before it allows the remote operation. The fact that three correct codes must be received is based upon current technology. The intent is to avoid susceptibility to random noise. In fact, more than three makes for a more robust system. The only problem with increased required occurrences is the length of time the operator must wait before the remote device begins to respond. The present invention is designed to make the reaction appear to be instantaneous from a user's point of view. To take advantage of power averaging, the code will be repeated at a rate of twenty times per second on average. Secondly, the transmitter uses an "ALOHA" messaging scheme. ALOHA is a messaging technique that allows multiple users to operate simultaneously on the same frequency.

When dealing with shared channels (a channel being an assigned frequency band), one must be prepared to resolve conflicts that arise when more than one demand is placed on the channel. For example, in the case of multiple garage door devices within close proximity, whenever a portion of the transmission of one user overlaps with the transmission of another user, then the two collide and "destroy" each other, unless a random access technique such as ALOHA is utilized.

Pure ALOHA permits a user to transmit any time it desires. If a user transmits a code word, and within some appropriate time-out period following its transmission

it receives an acknowledgment from the destination, then it knows that no conflict occurred. Otherwise, it assumes that a collision occurred and it must retransmit. To avoid continuously repeated conflicts, The retransmission delay is randomized across the transmitting devices, thus spreading the retry packets over time. This approach works most effectively with a transceiver on both ends. However, that basic ALOHA approach still works using the operator as the feedback for acknowledging the garage door has opened or closed. A basic system using ALOHA, the transmitter sends a coded message upon switch closure and then waits a period of time before retransmitting the message. This process is repeated until the operator releases the switch. The delay between messages is a random period of time. The time between messages is long with respect to the time it takes to transmit a message. The transmitter codes the RF using pulse modulation. Therefore, the transmitter does not emit RF energy while waiting to send the message.

Basic Receiver

The receiver is operational at all times waiting for the correct message to be decoded by the RF receiver. After the receiver get three valid messages, the remote operation is performed such as opening a garage door. This is one of three basic modes of operation. The second mode of operation is the entry of new valid codes. This is achieved by holding down the programming button "switch" and operating the new transmitter. The receiver reads in the coded message and saves the code word in the non volatile random access memory NOVRAM. The new transmitter is now capable of operating the remote system. The third mode of operation is clearing or

resetting of all stored codes in the NOVRAM of the receiver. This is done by turning power on while the programming button is pressed. Upon boot-up the microcontroller recognizes the depressed programming button and then erases the contents of the NOVRAM.

Manufacturing

For low cost manufacturing purposes, all receivers are initially configured during the manufacturing process with the same code. This is accomplished within the software design. This allows for simple testing of the receiver as it is being built.

The transmitter randomly selects a code word on initial power up. This gives the transmitter a unique code word that is stored in NOVRAM. The random selection of the code word is done partly with the hardware timer that is built into the microcontroller and through a software timer. Upon the initial power-on and boot-up process the microcontroller checks to verify that a valid code word has been stored in the NOVRAM. If there is no code word the microcontroller starts the hardware and software timers. The operator, some random time later, will push the button marked "Close the switch." This stops the counters and the microcontroller loads the contents of the counters into the NOVRAM as the valid code word. The operator is most likely to be a technician during the testing phase of the manufacturing process. The microcontroller is capable of counting very fast. The hardware and software counters count from zero to maximum count more than twenty times a second. After maximum count the counters automatically start over at zero. The operator pressing

the button randomizes the process. This random number algorithm can produce over a billion unique code words.

This method allows the transmitters and receivers to be built and tested independently. Transmitters and receivers are not matched pairs, nor do they require the setting of DIP (dual in-line package) switches. Replacement transmitters can be purchased and programmed into the receiver.

The invention also provides several alternative methods of programming the transmitter with unique codes. An additional connector could be used to down load information. However, this concept is inferior due to the cost and physical location constraints of the application. Instead, a technique has been developed that allows the information to be encoded on the power supply leads. Therefore, the unique codes can be downloaded without adding additional cost or complexity to the transmitter circuit. This is an important concept for making transmitters compatible with or vendors receivers. Current state of the art devices change codes by selecting settings on a DIP switch, on both the transmitter and receiver. With this embodiment, the user can program the transmitter with a compatible code and then set the dip switches on the receiver to match the transmitter. It is envisioned that a distributor will sell transmitters independent of the receiver for replacement of lost or broken transmitters. The distributor would concurrently provide a service of allowing the user to select a code to be programmed into the transmitter NOVRAM. This is accomplished with a special box that the user can plug the transmitter into and activate the programmer.

The process only takes a few seconds and allows the user to either pick a code or allow the box to randomly select a code and then print out the code word so that the dip switches can be properly set on the receiver.

Figure 43 is a schematic diagram which shows a power communications scheme, and is representative of how this feature may be implemented. The information is modulated onto the power line VBAT. Capacitor C3 is a DC blocking capacitor. Only the information passes through the capacitor. Resistor R4 pulls the input of the microcontroller to a high state. The two diodes CR1 and CR2 are used to clamp the voltages to valid logic states. The RXD input to the microcontroller is normally sitting at a logic high state until the information is sent over the power line. The microcontroller senses the high to low transition on the RXD input and begins receiving the information with a Universal Asynchronous Receive/ Transmit UART.

Figure 44 provides an example of the circuitry used to program the transmitter through the power line. Connector J2 has a 24 VDC power input. P1 is a standard 25 pin DIN connector used to interface to the serial port of a PC. The 25 pin connector could also be a 9 pin connector. A standard receiver is used for receiving information form the transmitter. The MAX222 U1 converts the RS232 of the PC to standard TTL levels. The PC receives information from the receiver via U1. The data from the PC used to program the transmitter drives the base of Q2 through the resistor R2. In this circuit, Q2 is used as a switch. When Q2 is on, CR1 clamps the base of Q1 to approximately 19 volts. When Q2 is off, the base of Q1 is pulled up to

the 24 volt supply level. Turning Q2 on and off causes the power on the J1 connector to swing from 24 volts "logic high" to 19 volts "logic low," As explained above, the microcontroller on the transmitter receives this information through the UART.

The programming box communicates serially with the transmitter via the power supply leads. The power supply leads are capacitively coupled to into the microcontroller's UART receive port (Universal Asynchronous Receive and Transmit). The UART transmit port is connected to the RF modulator. In one embodiment the programming box can communicate with the transmitter using full duplex protocol for diagnostics and testing purposes. Super-regenerative receiver topology is used to take advantage of its relatively low cost.

A significant feature of the transmitter is the fact that it does not require any tuning or optimization during the manufacturing process. This is primarily due to the ceramic transmission line resonator that does not require any tuning and is frequency stable to 0.5%.

Transceiver

Integrating the receiver with the transmitter for remote applications such as use in automobiles opens up a number of possible applications. One such application is the interrogation of home security systems before entering, in order to verify the house is safe to enter.

The transceiver can interrogate the remote device such as the garage door in order to verify the last state. This allows the user to check the transceiver and verify for example whether the door was closed or open after leaving the house.

Gated Communities

Figure 46 provides a block diagram of an integrated system for use in gated communities. Gated communities pose unique problems of security and access with which the present invention can be applied. First of all, convenience to the community members as well as providing limited access is of primary importance. An authorized person can drive up to the security gate and press the transmitter to open the gate. The same transmitter and code can be used to open the garage door of the person's residence within the gated community. The primary entrance into the gated community uses a multi-channel system that has been encoded with all the authorized codes.

The basic system can be integrated with a computer connected to the serial port. The computer can log the traffic in and out of the community. The system can be interfaced to a phone system either through a modem in the computer or dedicated phone system. This allows the system to be remotely interrogated or controlled. Special visitor codes can be entered for limited periods of time. Integrated with a voice recognition, special authorizations can be given to service personnel or for deliveries. The system can call and warn the person that the delivery has arrived and if the person does not respond back within a certain period of time verifying the

arrival, the system can call security personnel. The system can be integrated with a video system for logging purposes.

Another application is with a gated community with a guard. In this application the guard has the ability to interrogate each car as it goes through the entrance. In this case the unit or device in the car is capable of both transmitting and receiving as explained above.

In apartment complexes, codes can be added and removed instantly and remotely. This allows for restricting access of previous tenants of evicted tenants who do not return the transmitter.

Voice Recognition

In a preferred embodiment of the invention, a voice recognition circuit is utilized. This allows hands free operation of the remote transmitter for controlling the opening and closing of the garage. Since the set of verbal code words is very limited, a very simple voice recognition circuit can be utilized, keeping the cost of the unit low.

Infrared Applications

Infrared and other wireless approaches such as acoustic can replace the RF in each of the embodiments. In some cases, such as unlocking the front door of a home, IR is preferred due to its directivity and covertness.

Receiver Circuitry

The 900 MHz receiver shown in Figure 47 consists of an RF super regenerative receiver that interfaces to a microcontroller, which in this embodiment is manufactured by Phillips, part number P87C750. Any generic microcontroller IC will work in the receiver. U5 A&B make up the detection circuitry of the receiver. U1 is the NOVRAM IC used to store the valid codes. Q4 is used to light the LED D2 and turn on the relay via coil K1. The Rx Code Programming Button S1 is operated by the user for clearing the NOVRAM and for adding additional codes to the NOVRAM. U3 and U4 provide voltage regulation.

Transmitter Circuitry

Figure 48 is a schematic diagram the circuitry for a 900 MHz transmitter, which consists of a ceramic transmission line resonator, a resonator, a microcontroller and a NOVRAM. As in the receiver, the NOVRAM consists of a unique code word that is transmitted by modulating the oscillator. The microcontroller senses the user pushing the button S1 and begins to send the code word to the base of Q1. A logic high turns on the oscillator and a logic high turns off the oscillator. The oscillator operates at a low power level of approximately 2 mWatts.

Software

Figures 49, 50 and 51 provide software flow charts which indicate the process by which the basic receiver and transmitter operate. The fundamental feature is that

the same software resides in both the transmitter and the receiver. Pin 13 of the microcontroller is used to discriminate between the receiver mode or the transmitter mode. Essentially, the micro upon power-up tests the logic state of Pin 13. If the pin is high, the microcontroller behaves as a transmitter.

Other Applications

In broader applications, the system can be integrated as part of the control of home appliances and security systems. LCD display can be added to the transmitter, permitting the user to monitor various systems or appliances within the home from a remote location. For example, as the user leaves the home, the remote control device in the user's automobile can be used to interrogate the home, reporting the status of appliances or security systems. As the user returns home, the security system can be checked, the garage door can be opened, the outside lighting can be turned on, and the home heating or air conditioning can be turned on.

Although the specification has described the *Miniature Remote Control System* as a controller for operating garage doors from an automobile, it is capable of handling a wide variety of remote control applications. Although the specification has described the *Miniature Remote Control System* as being designed to fit within a cigarette lighter enclosure, the present invention is capable of being packaged for installation in a number of locations where power is readily available, such as a plug-in module on a dashboard or console.

The Housing

Figures 52 and 53 are side views that reveal the top and bottom of one of the preferred embodiments of the housing.

Figures 54 and 55 are cross-sectional views of the housing shown in Figures 52 and 53.

Figures 56A through 56F present views of the housing mold.

Figures 57A and 57B depict the ground ring.

Figures 58 and 59 are side views that reveal the top and bottom of one of the alternative embodiments of the housing.

Figures 60 and 61 are cross-sectional views of the housing shown in Figures 58 and 59.

Figures 62A through 62F present views of the housing mold.

Figures 63A and 63B depict the ground ring.

Figures 64A, 64B and 64C provide illustrations of a printed circuit board.

Figures 65A, 65B and 65C reveal the details of a transmitter button.

Figures 66A and 66B portray the transmitter cap.

Figures 67A and 67B illustrate the transmitter power ring.

Figures 68 through 74 furnish successive views of manufacturing steps which may be employed to construct a preferred embodiment of the present invention. Figure 68 shows the placement of ground and power rings GR & PR, while Figure 69 shows the placement of a printed circuit board assembly PCB. Figure 70 exhibits the deflection of power leads PL. This deflection is maintained through out the molding process by a pressure plate PP, and creates an intimate connection between the power leads PL and the ground and power rings GR & PR. The antenna ANT is pulled through a small hole in the pressure plate PP prior to locking the pressure plate PP in place.

Figure 71 shows how the mold M is poured in an "upside-down" position. The parts are captured and are held in place by epoxy. This method of attachment provides a housing which is strong and solid. This epoxy seal also insures a long service life by sealing out outside air, dirt and moisture. Figure 72 furnishes a view of the transmitter housing coming out of the mold M without a cap CA or a button BT. In this manufacturing step, the antenna ANT is coiled to allow for the addition of a cap CA and a button BT. Figure 73 provides a view the cap CA, the button BT

and the antenna ANT being added to the transmitter housing. Figure 74 offers an illustration of the placement of the identification sticker on the housing.

One preferred embodiment of the present invention provides a housing which encloses all the electronic components in the potting material. This feature offers a protective seal around the electronic components which greatly reduces the chances of a failure due to the intrusion of dirt or moisture or due to vibration, corrosion or other physical damage. The antenna ANT is enclosed under the cap CA in a cavity formed by the cap CA and the main body of the housing, which is formed from epoxy or another equivalent potting material. The length of the antenna may be changed to alter the desired transmission distance. The power and ground wires are spring-loaded. This feature maintains a constant, intimate and reliable coupling between the power and ground wires and the power and ground rings PR & GR. This connection is made permanent when the mold process for the potting material is completed. The invention may utilize any potting material which may be cast in a mold. The transmitted signal may be greatly altered by the selection of the potting material. In one of the preferred embodiments of the invention, the casting creates a perfect fit between the transmitter housing and the cigarette lighter receptacle. The shape of the housing may be easily adjusted or altered by changing the shape of the mold M.

CONCLUSION

Although the present invention has been described in detail with reference to particular preferred and alternative embodiments, persons possessing ordinary skill in the art to which this invention pertains will appreciate that various modifications and enhancements may be made without departing from the spirit and scope of the Claims that follow. The imaging equipment that has been disclosed above is presented to educate the reader about particular embodiments, and is not intended to constrain the limits of the invention or the scope of the Claims. The List of Reference Characters which follows is intended to provide the reader with a convenient means of identifying elements of the invention in the Specification and Drawings. This list is not intended to delineate or narrow the scope of the Claims.

LIST OF REFERENCE CHARACTERS

10	*Miniature Remote Control System*
12	Remote emitter
14	Remote receiver
16	Coded serial pulse train
18	Receiver antenna
20	Transmitter code
22	Receiver code
24	Receiver power converter
26	Perspective view of remote emitter
28	Cigarette lighter receptacle
30	Positive polarity connection
32	Negative polarity connection
34	Emitter body
36	Emitter retainer
37	Switch
38	Installed Controller
40	Illustration of approaching vehicle
42	Depiction of integrated garage door opener
44	Integrated garage door opener
46	Plan view of applications

48	Security gate receiver
50	Exterior light receiver
52	Landscape control receiver
54	Security system receiver
56	Interior lighting receiver
58	Climate control receiver
60	Transmitter circuitry
62	Emitter power supply
64	Emitter encoder
66	Emitter oscillator
68	Encoding chip
70	Trinary code input traces
72	Timing network
74	RTC timing resistor
76	CTC timing capacitor
78	Source resistor
80	Emitter inductor
81	Coupling transformer
82	Signal resistor
83	Emitter antenna
84	Remote receiver circuitry
86	Super-regenerative receiver
88	High frequency filtering circuit

90	High frequency filter capacitor
92	Filter transistor
94	Data amplifier
96	First operational amplifier
98	Data separator
100	Second operational amplifier
102	Receiver decoder
104	Relay
106	16 volt DC signal
108	Receiver power supply
110	First receiver board
112	Second receiver board
114	Production transmitter board
116	Side view of production transmitter board
118	Bare transmitter board
120	Circuit side of bare production board
122	Board traces
124	Composite view of production transmitter board
126	Surface mounted transmitterboard
128	Plan view of remote emitter
130	Spring
132	Snap ring
134	Detailed side view of remote emitter

136 Alternate transmitter embodiment

138 Sectional side view of alternate transmitter embodiment

140 Conductive pathway

141 Remote emitter to fit in Lincoln™ automobile

142 Remote emitter to fit in Mercedes Benz™ automobile

144 Extended remote emitter

146 Multiple button keypad

148 Single button

150 Extension receptacle

152 Miniature Transceiver Control System

154 Remote transceiver

156 Secondary transceiver

158 Information pulse train

160 Transceiver keypad

162 Transceiver microprocessor

164 Transceiver transmitter

166 Transceiver antenna

168 Transceiver receiver

170 Liquid crystal display

172 Function LEDs

174 Perspective illustration of remote transceiver

176 Power pickup

178 Remote transceiver power circuitry

180 Transceiver power supply

182 Power outputs

AC Heating and air conditioning system

ACC Secondary accessories

ANT Antenna

AT Standard ashtray

B Building

BAT Vehicle DC power source

BT Button

C Console

CA Cap

CL Cigarette lighter

CP Cellular phone

D Dashboard

ED External device

EL Exterior lighting

FD Fire detector

G Garage

GD Garage door

GDO Garage door opener

G Garage wall

GR Ground ring

IL	Indoor lighting
LC	Sprinklers
M	Mold
MNL	Manual button
PCB	Printed circuit board
PL	Power lead
PP	Pressure plate
PR	Power ring
S	Passenger seating
SA	Security and alarm system
SG	Security gate
V	Vehicle
VAC	Alternating current power source
VB	Vehicle body
W	Windshield